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A BREEDING COLONY UTILIZING A HAREM MATING SYSTEM WAS ESTABLISHED TO STUDY THE FEASIBILITY OF BREEDING CYNOMOLGUS MONKEYS, MACACA FASCICULARIS, IN MALAYSIA. TWO GROUPS CONSISTING OF 10 FEMALES AND ONE MALE EACH WERE EVALUATED OVER A 3 YEAR PERIOD. FORTY BIRTHS WERE RECORDED; ONE WAS STILLBORN, 11 DIED WHILE NURSING, AND 28 WERE WEANED. THE AVERAGE TIME TO WEAN OFFSPRING WAS 230 DAYS WITH AN AVERAGE WEIGHT AT WEANING OF 0.858 KG. THE AVERAGE TIME FOR CONCEPTION TO TAKE PLACE AFTER WEANING WAS 50 DAYS. OF THE 20 BREEDER FEMALES, SIX

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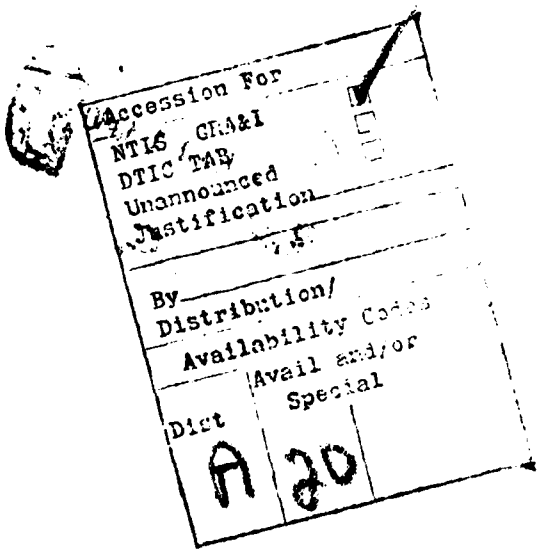
PRODUCED THREE OFFSPRING EACH, NINE PRODUCED TWO OFFSPRING EACH, FOUR PRODUCED ONE OFFSPRING EACH AND ONE REMAINED BARREN THROUGHOUT THE PROJECT. THREE DIFFERENT WEANING SYSTEMS WERE EVALUATED. THE BEST METHOD WAS CAGING THE MOTHER-INFANT PAIR WITHIN OR ADJACENT TO THE BREEDING ROOM FOLLOWED BY A TWO-PART CAGE SYSTEM WHICH ALLOWED THE INFANT TO CONTINUE NURSING AND ALSO OBTAIN SOLID FOOD INACCESSIBLE TO THE MOTHER.



Laboratory Animal Science

Establishment of a Cynomolgus Monkey (*Macaca fascicularis*) Breeding Colony in Malaysia: A Feasibility Study[1,2,3,4,5]

Robert M Werner, Richard D Montrey, Clifford R Roberts, Alfred Chin Thiam Tsoy and David L Huxsoll

Summary | A breeding colony utilizing a harem mating system was established to study the feasibility of breeding cynomolgus monkeys, *Macaca fascicularis*, in Malaysia. Two groups consisting of 10 females and one male each were evaluated over a 3 year period. Forty births were recorded; one was stillborn, 11 died while nursing, and 28 were weaned. The average time to wean offspring was 230 days with an average weight at weaning of 0.858 kg. The average time for conception to take place after weaning was 50 days. Of the 20 breeder females, six produced three offspring each, nine produced two offspring each, four produced one offspring each and one remained barren throughout the project. Three different weaning systems were evaluated. The best method was caging the mother-infant pair within or adjacent to the breeding room followed by a two-part cage system which allowed the infant to continue nursing and also obtain solid food inaccessible to the mother.

Key Words | Animal breeding — Reproduction — *Macaca fascicularis*

Interest in the breeding of nonhuman primates for laboratory use has increased in recent years. Numerous advantages have been ascribed to the use of colony-reared animals in many areas of biomedical research (1,2). In addition, wild caught animals are becoming increasingly difficult to obtain. The major effort toward providing colony-reared nonhuman primates has been the establishment of breeding colonies in countries where the animals are being used for research. Although there are many advantages to breeding the animals in the user country (1), there are factors which mandate the investigation of the feasibility of breeding of nonhuman primates in the country of origin. Among these advantages are greater availability of breeder animals and reduced cost (3). However, few attempts have been made to study the feasibility of establishing nonhuman primate production colonies in countries of origin.

The requirement for laboratory-reared cynomolgus monkeys (*Macaca fascicularis*) at the Institute for Medical Research in Kuala Lumpur, Malaysia afforded an opportunity to evaluate the breeding of this species in one of its countries of origin. Reported here are observations made on a colony of cynomolgus monkeys established and maintained near Kuala Lumpur.

Materials and Methods

The colony consisted of two groups of monkeys each containing 10 females and one male. Group 1 was established in September 1975 and Group 2 was established in February 1976. The animals were all wild caught and

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[3]The authors would like to thank George F de Witt, Director, Institute for Medical Research, for his enthusiastic support of this study and his permission to publish this paper.
[4]The views of the authors do not purport to reflect the position of the Department of Defense.
[5]Reprint requests to: Commander, US Army Medical Research Unit, Institute for Medical Research, Jalan Pahang, Kuala Lumpur 02-14, Malaysia.

were subjected to a 6-month period of conditioning prior to final grouping. During the conditioning period, each monkey was treated twice for gastrointestinal parasites with levamisole[6] and received five tuberculin tests. Subsequent to establishment of the colony, the monkeys were tuberculin tested every 6 months. A commercial monkey diet[7] and water were provided *ad libitim,* and the facility was cleaned once daily.

The breeding building was constructed of wood support posts with walls of 5 x 5 cm, 14 gauge wire mesh and zinc sheet roofing. The floor was a poured concrete slab. The building design provided two separate breeding rooms 2.4 m wide x 9 m long x 2.1 m high. Adjacent rooms served to house individual cages when necessary.

Three different caging systems for nursing mothers and their offspring were evaluated. One method was to allow the nursing mother and infant to remain in the breeding room with the rest of the group and remove the infant once it had been weaned. Another technique was to place the female and nursling in a separate wire mesh cage (each cage provided 0.4 m^2 of floor space) within or adjacent to the breeding room shortly after parturition. This technique enabled the mother to maintain some association with her original breeding group but prevented injury to the infant by other members of the group. A third system was a modification of the second method whereby, towards the end of the the nursing period, the mother-infant pair was placed in a two part cage. This cage allowed the infant to crawl through a small opening and obtain solid food undisturbed by the mother. Once the infant was completely weaned, it was removed and the mother was returned to the breeding group.

Complete records were maintained on all of the animals and included dates of birth and weaning, complete medical histories and necropsy reports. In addition, all of the offspring were weighed once a month, and the weights were recorded.

Throughout the study, an animal dealer with over 20 years of experience in caring for nonhuman primates in Malaysia supervised the basic colony operation. All cleaning and maintenance was done by two laborers hired by the dealer. Professional veterinary input was limited to consultation with the dealer, incidental medical attention and gathering and evaluation of data reported in this paper.

The colony remained in continuous operation from its inception in September 1975 to termination in November 1978 except for a period of 4 months from December 1976 to April 1977 when all of the animals were housed in separate cages. This was necessitated by a requirement to change the location of the colony.

Results

Production: From the inception of the project through termination, production for Group 1 was 23 offspring (14 males and nine females). Of the 23 offspring, one was stillborn, six died during the nursing period, and 16 were weaned. The average time for weaning was 245 days (standard deviation 30 days, range 184–295 days). The mean weight and standard deviation at weaning was 0.994 kg ± 0.166 kg (range 0.759–1.185 kg) for females and 0.844 ± 0.076 (range 0.728–0.963 kg) for males. Of the 10 breeder females, five produced three offspring each, four produced two offspring each, and one remained barren throughout the project. The average interbirth interval excluding the nursing period for these 23 births was 198 days (standard deviation 58 days, range 151–331 days). Using a 164 day pregnancy for calculation (4), the average time for conception was 34 days. The compatibility of the breeder animals remained good throughout the project, and no animals had to be replaced.

Group 2 which was started in February of 1976 produced a total of 17 offspring (11 males and 6 females). Of this total, five died during the nursing period, and 12 were weaned. The average time required for weaning was 207 days (standard deviation 71 days, range 96–286 days). The mean weight and standard deviation at weaning was 0.686 ± 0.206 kg (range 0.535–0.988 kg) for females and 0.860 ± 0.086 (range 0.780–0.930 kg) for males. Of the 10 breeder females, one produced three offspring, five produced two offspring, and four produced one offspring each. The average interbirth interval excluding the nursing period for the 17 births was 236 days (standard deviation 77 days, range 161–332 days). The average time for conception was 72 days. Initially this group experienced considerable

[6]Nemacide. Imperial Chemical Industries Ltd, Kuala Lumpur, Malaysia.
[7]Gold Coin. Johor Bahru, Malaysia.

compatibility problems resulting in the replacement of the original male and seven of the females during the first year. The period of individual housing, necessitated by a colony location change, occurred shortly after the replacement of these incompatible animals. During this 4-month period, no pregnancies were observed, and no births occurred. When the group was reunited in April of 1977, the group compatibility was similar to that described for Group 1.

Weaning systems: Of the three weaning systems employed during the study, allowing the nursing mother and infant to remain in the breeding room was the least successful. Although this method was the least time consuming for maintenance personnel, it resulted in considerably more fighting in the group, and injuries often were sustained by the newborn. Four infant deaths resulted from trauma. Therefore, this technique was abandoned, and no offspring were weaned by this method.

To eliminate the fighting problem, the second system was initiated which utilized an individual cage inside or adjacent to the breeding room to house the mother and offspring. Sixteen animals were weaned using this method. The mean time and standard deviation for weaning was 241 ± 42 days (range 147–290 days). This system eliminated much of the fighting, and no infant deaths were attributed to trauma while it was employed.

The third system initially placed the mother and offspring in an individual cage as described in the second system. As the infant approached weaning age, the mother and offspring were transferred to a two-part cage which allowed the infant access to food without the interference of the mother. This system was initiated because it was observed that often the mother became a hindrance to the weaning process by not allowing the infant to eat solid food even though it showed interest in trying to do so. Twelve animals were weaned using this system, and the mean time and standard deviation for weaning was 209 ± 66 days (range 96–269 days).

Weight gains: The mean and standard deviation for body weight of the infants is shown in Table 1.

Death loss: A total of 12 offspring died during the study. One was stillborn (cause

Table 1

Average weight for various age categories of cynomolgus monkeys born and raised in captivity

Age (months)	Number of animals	Sex	Mean weight (kg)	Standard deviation	Age (months)	Number of animals	Sex	Mean weight (kg)	Standard deviation
0-1	22	M	0.311	0.057	12-14	13	M	1.166	0.091
	13	F	0.327	0.055		11	F	1.177	0.087
1-2	21	M	0.394	0.073	14-16	11	M	1.194	0.145
	14	F	0.396	0.063		8	F	1.212	0.108
2-3	19	M	0.464	0.080	16-18	11	M	1.271	0.157
	14	F	0.506	0.096		8	F	1.300	0.095
3-4	17	M	0.532	0.082	18-20	10	M	1.405	0.098
	9	F	0.611	0.118		7	F	1.389	0.162
4-5	17	M	0.612	0.101	20-22	10	M	1.468	0.105
	10	F	0.663	0.120		8	F	1.426	0.185
5-6	16	M	0.659	0.082	22-24	8	M	1.499	0.081
	8	F	0.759	0.142		9	F	1.531	0.205
6-7	15	M	0.711	0.099	24-26	6	M	1.598	0.123
	10	F	0.819	0.132		7	F	1.741	0.130
7-8	16	M	0.798	0.096	26-28	6	M	1.586	0.147
	7	F	0.926	0.126		8	F	1.717	0.133
8-9	15	M	0.877	0.091	28-30	5	M	1.668	0.089
	6	F	1.016	0.091		5	F	1.848	0.172
9-10	5	M	0.922	0.135					
	8	F	1.013	0.082	30-32	6	F	1.926	0.152
10-11	12	M	1.006	0.149					
	6	F	1.060	0.074	32-34	6	F	1.881	0.189
11-12	8	M	1.033	0.118					
	6	F	1.135	0.141	34-36	4	F	1.970	0.238

undetermined). Four died as a result of trauma shortly after birth (these losses occurred prior to initiation of separate weaning cage system). Three died from stress and dehydration associated with weaning (these losses occurred prior to utilization of the two-part weaning cage previously described). The cause of death in the remaining four animals could not be determined because postmortem autolysis precluded adequate evaluation.

Discussion

This study demonstrated the feasibility of breeding cynomolgus monkeys in captivity in Malaysia with minimal physical facilities. Additionally, laborers who had no prior experience in handling and caring for nonhuman primates proved quite adaptable, with little training, to the duties required for the day to day maintenance of a breeding colony.

The difficulty encountered in establishing compatibility in the breeding groups has been observed by others (5). If initial periods of incompatibility are discounted in making calculations, both breeding groups demonstrated excellent production averaging approximately one offspring per mother per year. This average probably could be increased if the young could be weaned sooner or placed on an artificial nursing system. This change, however, would result in increased labor costs in terms of time involved and skill required.

Many of the developing countries that are the source of monkeys for biomedical research are interested in preserving their rapidly dwindling populations of nonhuman primates and at the same time are actively seeking the means to provide income and employment for their people. Establishment of nonhuman primate breeding colonies could be a possible step toward achieving both of these goals.

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